A high-speed low-power CAM-based search engine

May 26th, 2000

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This application is submitted in the name of the following inventor(s).

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TITLE OF THE INVENTION

High-Speed Low-Power CAM-Based Search Engine

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates generally to search engines for routers.

Related Art

The Internet was created for the purpose of sharing information between research universities and government agencies. However, with greater commercial and individual use, Internet traffic has grown exponentially, leading to increased problems associated with routing messages. Messages are routed (or switched) by routing or

switching devices, herein called "routers." Routers serve as the principal devices by which messages are received and forwarded using communication paths. Routers preferably select substantially optimal paths for messages in response to factors related to the condition of the paths and the status of the network.

One known problem is that router speed is often not sufficient to keep up with message traffic. Messages are sent using packets, relatively smaller blocks of data that are received by a router (or switch) and forwarded on to their destination(s). Packets include at least two parts, (1) a header with the address of the source and destination computers, and (2) data to be sent with the packet. For example, upon sending an e-mail message to a recipient, the message can be broken into multiple packets for travel on different communication paths within the Internet to the ultimate destination.

In preferred embodiments, routers use known protocols including TCP (transmission control protocol) and IP (internet protocol). As known in the art of routing messages, TCP breaks messages into data packets and reassemble them in order once they reach their ultimate destination. As known in the art of routing messages, IP assigns each packet a unique source IP address (and at least one IP destination address). Each router reads the destination IP addresses and determines which path is the best one for the packet to take its ultimate destination. In preferred embodiments, the router makes this determination in response to a routing table of routing treatments for each destination IP address.

The routing table includes a set of routing treatments associated with each destination IP address (and possibly also responsive to the source IP address in the case of multicast packets). The routing table can be constructed by the router in response to information about the network gleaned by the router, received by the router from other routers, and in response to other factors.

In the presence of relatively heavy network traffic, the router can become overloaded; that is, packets arrive at the router faster than the router can process them. In such cases, excess packets are queued for their particular input interface at the router, and remain queued until processed. If the queue overflows, the router can be forced to refuse to process one or more packets, causing those packets to not reach their destinations. Although other message sending protocols generally have retry techniques for response to this problem, message retry can be substantially time consuming and result in performance degradation at the router.

One known technique to improving router speed includes using a CAM (content addressable memory) to speed operation of the router in accessing its routing table. Although this technique has the advantage of improving router speed, it is subject to several drawbacks. First, CAM devices have relatively high power requirements, thus requiring expensive packaging. Second, CAM devices have relatively limited amounts of memory that can be stored on a single chip. Third, CAM devices are relatively difficult to

coordinate among multiple chips, with the result that CAM size can become a limiting factor for router operation.

Accordingly it would be advantageous to provide a technique for CAM lookup in a router that is not subject to drawbacks of the known art.

SUMMARY OF THE INVENTION

The invention provides a method and system for integrating a CAM (content addressable memory) based ASIC (application specific integrated circuit) to allow lookups to keep up with message speeds over optical fibers.

In a preferred embodiment, the routing table includes at least one, and possibly many, chips with CAM memory banks. Each chip contains entries from a selected range of the address space, and within each chip those entries are further divided into several banks. Preferably, each bank contains entries of identical prefix length. Depending on the number of entries for each prefix length on each chip, several banks may be required to store entries for a single prefix length. Within those several banks, each one includes entries from a selected address range. Thus, each address lookup need only activate one bank per prefix length in order to obtain a lookup match.

A Content Comparable Memory (CCM) is contained within each CAM bank; this CCM stores and compares the least possible address that will match the entries in the table with the incoming address. If the incoming address is found to be greater or equal to the data stored in the CCM but less than the data in the next bank's CCM which contains addresses of the same prefix length, the incoming address will be directed to the rest of the CAM bank for comparison.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In this application, a preferred embodiment of the invention is described with regard to process steps and data structures. Those skilled in the art would recognize, after perusal of this application, that embodiments of the invention can be implemented using circuitry or other structures adapted to particular process steps and data structures, and that implementation of the process steps and data structures described herein would not require undue experimentation or further invention.

TECHNICAL APPENDIX

The enclosed technical appendix includes further information and detail regarding the invention and a preferred embodiment thereof. The enclosed technical appendix is an integral part of this application, and is hereby incorporated by reference as if it were fully set forth herein.

Alternative Embodiments

Although preferred embodiments are disclosed herein, many variations are possible which remain in the concept, scope and spirit of the invention, and these variations would be clear to those skilled in the art after perusal of this application.